XX.

The Sun a small Star.

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Of all the efforts to determine the parallax of stars, both by direct and differential methods, only ten or twelve cases can be cited with any show whatever of success. In α Centauri it amounts to 1″, which is more than double the quantity imputed to either of the others. The conclusion follows, among astronomers, that the stars generally are immensely distant bodies, shining like the Sun with light of their own, and forming a great family of which he is an individual member.

The sum total of light given off by any luminous body can be computed where its distance is known; and it is supposed, from such computation, that several of these stars must considerably exceed the Sun in intrinsic lustre, while 61 Cygni falls below him. Therefore, though classed in one family, inequalities are admitted, and to what extent they may reach among the millions, visible and invisible, we cannot know; but, from all the analogies of nature, we may safely conjecture that the extremes are very great.

If we admit this, and suppose for all the stars in existence a mean equal to our Sun, or even less, those *visible* must possess a mean in brightness much in excess of his; for, by the laws of perspective, the smaller would be lost to our view, at distances from which the brighter might glow, even as first magnitude. This reasoning would apply to telescopic magnitudes as well as to those visible with the naked eye.

Believing this to be true, I have felt a desire to possess some method of making photometrical comparisons between the light received from the Sun and that from a star more reliable than those in common use. If you were to go within the tropics, and sink a well to the depth of several hundred feet, and place yourself at the bottom while an assistant should close the top to produce total obscuration, except one small

hole, in which a lens might be fitted, of the finest material and finish, having a focal distance of the one hundred-thousandth part of the whole distance between your eye and the lens; then by viewing through it the vertical sun, in a clear sky, you would see it reduced exactly as though removed 100,000 times its present distance; and it would barely exceed the brightness of α Lyræ.

From the great number of experiments I have made, I am led to believe this the most reliable method of reducing the Sun's light, for comparing it with any given celestial object. You can free your observation entirely from the distracting effect of daylight, and even an object so bright as the Sun can be reduced by one single plano-convex lens, at one step, to equal a star of the sixth magnitude, if desirable; and when the focal distance of your lens is known, and the distance between your lens and your eye is known, the amount of reduction can be known as readily as you can find how many times the smaller is contained in the larger distance. I have no such well or mine, but a horizontal under-ground chamber 230 feet in length, one end terminating in the cellar of my workshop, and the other communicating with the surface of the ground by a vertical opening one foot square and five feet deep, is a complete equivalent, except that its use involves the necessity of twice reflecting the Sun's light, once by a mirror, and once by a prism of total reflection.

Between the end of the chamber and the vertical opening is a partition with a perforation two inches square, which I can close with plates, containing such lenses as I may wish to use. Within the vertical opening, contiguous to and facing the lens, the prism is placed to receive the Sun's light from the mirror above, and reflect it horizontally through the lens into the chamber.

When a lens one thirty-fourth of an inch in focal distance was employed, on the 24th of November, 1862, the Sun near the meridian and sky remarkably clear, by an observer in the cellar, 230 feet distant, the light received was estimated scarcely equal to that of α Lyræ.

Here the reduction of diameter was only 93,840 times, with the lens and prism very perfect, and cleaned for the occasion.

Three perforations were selected through a strip of thin brass, the largest of which, when held to the eye, should admit light enough for steady visibility; the next, visibility by fits; and the smaller, but little less, producing invisibility.

Three, myself and two sons, took a part in the observation, and with results showing the most perfect equality in our eyes; and when one had been in darkness for fifteen minutes, another fresh from the glare of day, taking his place, would see within two minutes as well, and as well we became satisfied, as we could with any allow-

ance whatever of time and shading. The evening of the 24th of November proved clear and favorable as the day; when the mirror and prism, placed at the same angle, were combined and applied to view α Lyræ, from five to six hours west of the meridian, through the same perforations in the strip of brass.

I suppose the percentage of loss by the prism and mirror would be the same with both objects; so that an allowance for the lens only is to be made; which, according to the best means of judging in my power, would be about ten per cent. Since we found the star and Sun rendered sensibly equal in the above comparisons, it would appear that a removal in space to 103,224 times his present distance would reduce the light of the Sun to an equality with that of the star in question. This is less than half the supposed distance of the nearest star in the whole heavens.

Coupled as this single determination has been with many preliminary experiments and studies, I am prepared to believe that it is very near the truth; though differing largely from the photometrical deductions most generally accredited, and most frequently quoted by astronomical writers. The earth itself, it is supposed, was once a self-luminous body; and there may exist innumerable suns like ours, or even less, within the limits of, and interspaced with, those which decorate a nocturnal sky, and yet remain unknown to man. This, however, would depend much upon the actual diversity existing among them; but that the Maker has chosen variety there, as well as in our more immediate surroundings, I see no reason to doubt. The inequality of such binary stars as ζ Herculis and δ Cygni, which cannot be caused by unequal distances of the components from us, are sufficient to confirm such a conclusion. If we suppose the extremes to be many millions to one, as they are in the planets of our system, and give due weight to the effect of celestial perspective, we could not but expect to find our glorious Sun a small star, if ever adequate means could be devised for demonstrating the true relationship between him and the hosts which are gleaming from such immeasurable distances beyond. The planet Jupiter is sensibly the fourth luminary in the heavens, and yet his four satellites are invisible to the naked eye, though at precisely the same mean distance from us; and further, there exist more than threescore of planets, well known, all of telescopic magnitudes, at distances less than that of Jupiter.

In viewing the Sun reduced 93,840 times, in the dark chamber, I could have stated that it was seen in contrast with a darkness deeper than that of any nocturnal sky, which would favor the supposition that the difference in light between that and α Lyræ might be even less than 10,655,194,176 to 1; but I have no desire to differ more than I feel obliged to do from the teachings of those who have preceded me in this interesting field of research.

The number of stars exhibited in the whole heavens by the more powerful telescopes is not so great, when compared with the smaller instruments and with the naked eye, as theoretically it should be; a fact explained by astronomers, on the supposition that a portion of the light is absorbed or extinguished during its passage through such immense ranges.

Now perhaps a different explanation might be found by assuming such vast differences in the intrinsic brightness of stars, scattered and intermingled through all space, as for aught we know may exist. Near us the small as well as large ones would be seen; but a few billions of miles in depth, at the outer limits of telescopic penetrability, carried over the whole sphere, would furnish room for concealment to hosts of bodies like our Sun, while a few only of very unusual bulk and brightness, interspaced with them, would appear as the faintest discernible points of light, when viewed through the most potent telescope to which the eye of man has ever been applied.